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WIP: Towards the integration of global affairs literacy and awareness with technical competence in engineering education

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Abstract

In an increasingly interconnected world, engineering education must extend beyond providing technical proficiency to include an understanding of the international affairs that shape technological advancement. Engineers operate within systems influenced by global agreements, economic policies, and ethical standards that have profound implications on innovation and implementation. Thus, the contribution of this paper is a pedagogical initiative, which is a curriculum framework, designed to embed global affairs awareness into engineering programs, in order to cultivate global policy aware and literate engineers, capable of internationalizing their technical expertise. The originality of this work is the operationalization of the curriculum framework through the Global Affairs Informed Engineers (GAIE) Competency Model (GCM) and a three phased integration supported by ready to use policy simulations and backgrounders. The differentiating aspect of this initiative is the utilization of educational resources from the Council on Foreign Relations (CFR). Additionally, resources from global organizations such as the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the National Academy of Engineering (NAE) are leveraged. These organizations provide educational resources that can help students understand how global systems and decisions influence technology development.

The first phase of the curriculum framework focuses on methods that can be adopted to seamlessly align technical instruction with global affairs literacy in engineering programs. Relationship between policy and technology development in critical sectors such as energy, telecommunications, cybersecurity, Artificial Intelligence (AI), supply chain management (SCM), and climate adaptation are explored in the second phase. Students examine how international agreements, trade policies, and global economic trends shape engineering practice and research. Case-based learning modules are utilized to illustrate how global policies influence design decisions, funding priorities, and ethical considerations. In the third phase, students engage in cross border collaborations and discussions that expose students to how to connect local solutions with global challenges, thus fostering global citizenship. This three phased model aligns with the American Society for Engineering Education (ASEE) mission to produce socially responsible and globally competent engineers. Moreover, this paper contributes to ASEE efforts on disseminating the importance of global awareness and interdisciplinary learning in shaping the next generation of engineers. The initiative also enables the achievement of the Accreditation Board for Engineering and Technology (ABET) student learning outcome (SLO) 2-7.

The research provides an evidence based curriculum framework for integrating international perspectives into engineering programs so that students are prepared to navigate the socio-political-global dimensions of technical decision making. The research methodology employs a mixed methods approach to assess impact, using pre and post surveys, student reflections, and faculty feedback to evaluate students' understanding of how policy influences engineering design and innovation. Ultimately, this work seeks to produce Global Affairs Informed Engineers (GAIE). A GAIE is an engineer who can bridge technical competence with international awareness, contribute effectively to solving complex global challenges and take on global leadership positions in the engineering field.

Introduction

Engineering in the twenty first century is deeply intertwined with global political, economic, and environmental systems. Therefore, modern engineers must be prepared to operate within complex socio-technical environments shaped by international agreements, geopolitical tensions, and global sustainability goals [1], [2], [3]. The emergence of technologies such as Artificial Intelligence (AI), cybersecurity support infrastructure, renewable energy systems, and digital governance structures has intensified the need for engineers who understand how global policy decisions influence technological innovation [4], [5], [6], [7], [8]. As a result, engineering education must evolve to cultivate policy literate and globally competent engineers capable of addressing transnational, societal and human problems.

However, traditional engineering curriculum remains heavily focused on technical content and provides limited exposure to global policy, governance, or diplomacy [1], [9], [10]. While this pedagogical approach has produced technically proficient graduates over the decades, it has also created gaps between engineering practice and the global contexts in which engineering solutions are deployed. Studies show that engineers now encounter policy driven constraints related to global guidelines, regulations and standardization, data privacy rules, cybersecurity protocols, climate change and sustainability mandates [3], [6], [11]. Without structured exposure to these regulations, policies, outlook and perspectives, engineering students may struggle to understand the broader implications of their technical decisions as engineers. The Accreditation Board for Engineering and Technology (ABET) also reinforces the importance of preparing engineers who can evaluate global, economic, environmental, and societal impacts of engineering solutions [12]. ABET's related criteria emphasize ethical responsibility, communication skills, teamwork, and the ability to engage in lifelong learning, which are competencies that align closely with global policy literacy[13].

International treaties and mandates such as the United Nations Sustainable Development Goals (SDGs) [8], the Global Digital Compact (GDC) [14], and Global Climate Adaptation (GCA) frameworks [15] further emphasize the need for engineers that are informed about global policies and ethically responsible [17] in their engineering practice. These pacts by global organizations shape national engineering priorities, funding landscapes, and regulatory environments. For example, renewable energy engineers must understand how global climate agreements influence national energy transitions [18], while cybersecurity professionals must navigate international cyber norms and geopolitical risks [19], [20], [21]. AI developers face global debates on algorithmic transparency, data ownership, privacy and sovereignty including ethical governance [22], [23], [24]. These examples illustrate the growing interdependence between engineering and global policies as mentioned in [25] and [26].

Therefore, the contributions of this work are two folds. First, to present and implement an initiative that will enlighten engineering students about the interdependence highlighted. The initiative is a curriculum framework that integrates global policy perspectives into engineering education using mostly policy resources from the Council on Foreign Relations (CFR) and supplemental educational information from related global organizations. CFR's educational tools which include model diplomacy simulations, global conflict trackers, webinars, expert interviews and policy backgrounders [4], [19], [22], [27] offer accessible, research-based resources that illuminate global policy contexts relevant to engineering. By integrating these resources into engineering curriculum, the presented framework aims to provide a three-phase platform that contributes to the cultivation of global affairs informed engineers (GAIEs). GAIEs are engineers who can critically analyze how international policy decisions influence innovation, sustainability, and technological equity. In phase one, to enable students to connect engineering concepts with international governance structures, the initiative utilizes strategies that can facilitate the embedding of global policy analysis into existing engineering courses. Phase two examines the policy-technology interface and identify the resources from CFR and global organizations that will help students understand how global policy decisions and ethical issues shape emerging technologies such as AI, cybersecurity systems, and renewable energy systems. The last phase emphasizes cultivation of global perspectives by utilizing international case studies and cross-border collaborations, to align with evidence based research that shows how global competency enhances engineering problem solving and ethical reasoning. The second contribution of this work is the introduction of a novel model termed GAIE competency model (GCM). The GCM is a set of six measurable learning outcomes that are aligned with global policy learning and engineering practices. The GCM enables the operationalization of the GAIE through six measurable competencies that are achieved through the three phases of the curriculum framework and contributes to ABET student learning outcomes (SLO) 2-7.

Integrating global policy perspectives into engineering education strengthens students' socio-technical reasoning, ethical awareness [17], and interdisciplinary communication skills. These competencies are in demand by employers and global engineering organizations [8], [24] [25], [28],[29]. This work in progress paper resonates ABET's outcomes and ongoing ASEE discussions towards building globally competent engineers, creating an interdisciplinary learning environment and exposing students to the role of engineering in addressing global challenges. By primarily leveraging CFR resources, the proposed curriculum framework offers a scalable, adaptable model for preparing engineers to lead in a world where technology and international affairs are deeply interconnected. The paper is organized as follows. Section 2 provides a review of existing literature and summarizes gaps that were identified. Section 3 presents the research methodology. The framework, integration action plan options and expected outcomes and benefits are presented in sections 4, 5 and 6 respectively. Section 7 concludes the paper.

2. Literature Review

Over the past decade, literature on engineering education, global policy, technology governance, and interdisciplinary Science Technology Engineering Math (STEM) learning has increased significantly. These plethora of studies have highlighted that engineering practice is inseparable from global political, economic, and environmental systems. Thus, engineering curriculum must evolve to reflect this reality [1], [3], [6], [25]. This section reviews four areas of scholarship that informed the proposed curriculum framework.

2.1 Global Competency in Engineering Education

Recently, global competency has become a central theme in engineering education research. Engineers must be able to work across cultural, political, and disciplinary boundaries to address complex global challenges [1], [6], [18]. Moreover, research shows that global competency enhances students' ability to understand diverse perspectives, collaborate internationally, and evaluate the societal implications of engineering decisions [2], [8], [26]. Certain reports and studies such as [3], [20], [25] reiterate the importance of integrating global perspectives into core engineering courses rather than relegating them to electives or study-abroad programs. These studies present a paradigm shift that reflects a broader recognition that global awareness is not an optional skill but a fundamental component of the engineering profession. According to [6], embedding global policy content into technical courses strengthens students' socio-technical reasoning and prepares them adequately for careers in engineering and technology, which are globalized fields. Also, ABET as an accreditation body further reinforces the need for global competency, requiring graduates to consider global, cultural, social, environmental, and economic factors in engineering solutions [12].

2.2 Technology Governance and International Policy

The rapid evolution of new technologies e.g. AI, cybersecurity systems, and digital infrastructure have intensified interest in technology governance and ethics. As emphasized in [3], [4], [26] and [27], today's engineers must understand how global policy shapes the innovation, development, deployment, and regulation of new technologies. Some governance and policy concerns are:

- AI Governance: AI governance and ethics [22], [23] have emerged as a critical area of global policy research. Debatable topics include algorithmic transparency [10], data sovereignty [28], ethical AI design [10], and international regulatory harmonization [24]. These issues directly affect engineering practice, as AI developers must navigate complex policy environments that vary across nations and jurisdictions.
- Cybersecurity and Digital Governance: International cyber norms [20], cross-border data flows [21], and global digital governance frameworks [14] shape the design and operation of cybersecurity systems. In addition, cybersecurity research emphasizes the geopolitical dimensions of digital infrastructure [21]. Thus, engineers working in cybersecurity must understand these policy contexts in order to design resilient and compliant systems for global applicability.
- Energy and Climate Policy: Global climate agreements [15] and geopolitics of energy [19] significantly influence engineering decisions in renewable energy, the development of environmental systems [30] and infrastructure resilience [31], [32]. In alignment with these policies, engineers must be familiar with international climate and energy frameworks when designing systems so as to achieve global sustainability goals.

2.3 Sustainability and Socio-Technical Systems

It cannot be overemphasized that sustainability points out the interconnectedness of engineering, society, and the environment. So, innovative technology solutions must be evaluated within broader socio-technical dimensions. These dimensions are across political, economic, and cultural landscapes [4], [26]. A few existing talking points on sustainability are:

- Global Sustainability Frameworks: International sustainability frameworks such as the United Nations Sustainable Development Goals (SDGs) [8] provide a global context for sustainable engineering practice. Research-based evidence shows that integrating SDG aligned content into engineering curriculum enhances students' ethical reasoning, systems thinking, and global awareness [2], [24], [29].

- Climate Adaptation and Resilience: Climate adaptation research emphasizes the need for engineers to design systems that are resilient to global environmental risks. It is important to understand international adaptation strategies, global risk assessments, and cross-border environmental governance [19], [15].

2.4 Interdisciplinary STEM Learning and Engineering Pedagogy

Over the last decade, interdisciplinary learning has garnered attention and become a defining feature of modern engineering education. It has become evident that engineering students must be able to integrate knowledge from multiple domains including policy, ethics, and social sciences in order to create solutions and innovations that address global challenges [1] [6], [25], [32]. To support interdisciplinary learning, pedagogical approaches being explored include:

- Case-Based and Problem-Based Learning: Case-based learning (CBL) and problem-based learning (PBL) are widely recognized as effective pedagogical strategies for developing interdisciplinary reasoning. Evidence shows that these approaches enhance students' ability to analyze real-world problems, evaluate trade-offs, and consider policy constraints [3], [6], [13], [15].
- Experiential and Simulation-Based Learning: Simulation-based learning such as policy negotiation simulation has gained traction as a method for teaching global policy concepts in engineering contexts. Studies show that simulations improve students' communication, collaboration, and systems-thinking skills [3], [18]. CFR's model diplomacy simulations align closely with these pedagogical approaches.

2.5 Summary of Literature Gaps

Despite growing interest in global competency, technology governance, and interdisciplinary learning, several gaps remain. The identified gaps are:

- Engineering curriculum lacks structured frameworks for integrating global policy content.
- The opportunity to directly teach engineering students about the effect of policy contexts and dimensions, along with analysis of real-life cases rarely exists in engineering courses.
- Few studies have explore how global policy simulations can be adapted for engineering education.
- Scalable, resource-efficient frameworks that can be adopted without major curriculum restructuring are lacking.

These gaps show that there is a need for comprehensive, adaptable frameworks such as the one proposed in this paper. The proposed curriculum framework integrates global policy perspectives into engineering education using accessible, and readily available research-based resources.

3. Research Methodology

The stages of the research methodology for this work are presented in this section. It is worth noting that the proposed curriculum framework has been designed to ensure academic rigor, pedagogical feasibility, and alignment with engineering education standards. Thus, the methodology integrates curriculum mapping, qualitative content analysis, and evidence-based instructional design principles that support the scalable and adaptability of curriculum frameworks for engineering programs. The stages of the research methodology are described as follows.

3.1 Framework Development

The first stage is a systematic design of the framework which involves outlining the relevant and overarching policy related themes to be integrated as learning contents. This is followed by a review of existing undergraduate and graduate engineering curriculum. The goal is to identify common structures, required courses, elective pathways, and opportunities for interdisciplinary integration. The stage also includes an analysis of course syllabi, program learning outcomes, and accreditation requirements to determine where global policy content could be embedded without overloading or displacing essential technical contents. The curriculum mapping process enables the alignment of potential policy content and modules with ABET student outcomes, particularly those related to ethics, global impact, and societal considerations. Such mapping is necessary as some curricula may already have indirect references to societal impact, sustainability, or regulatory constraints. However, since these are only references, structured engagement with global policy frameworks may still be lacking.

3.2 Selection of educational resources

The second stage focuses on identifying CFR and global organization policy related resources that align with engineering education needs. CFR offers a wide range of materials, including model diplomacy simulations, global conflict trackers, backgrounders, expert interviews, and issue briefs [4], [19], [22], [27]. Among other global organizations, the UN [8], NAE [32] and World bank [30] provide case studies and real-life examples. The suitability and selection of these resources are through the following criteria:

- Relevance to engineering domains such as energy policy, cybersecurity, infrastructure resilience, climate governance, and technology regulation.
- Accessibility for undergraduate students, graduate students and faculty without prior training in political science and policy.
- Compatibility with case-based and problem-based learning.
- Nonpartisan research-based content suitable for academic settings.
- Scalability and adaptability across diverse engineering courses.

Using these criteria, a curated set of CFR and global organization resources are selected and mapped to the curriculum to create a structured integration plan.

3.3 Pedagogical Approaches

The third stage identifies pedagogical approaches that support interdisciplinary learning and facilitate the integration of global policy content into technical courses. Three primary pedagogical approaches selected based on engineering education and interdisciplinary STEM learning research [7], [13] are:

- Case-Based Learning (CBL): CBL allows students to analyze real-world scenarios where engineering and policy intersect. It encourages critical thinking, contextual understanding, and the ability to evaluate tradeoffs between technical and policy considerations.

- Problem-Based Learning (PBL): PBL engages students in solving open-ended problems that require interdisciplinary reasoning. It is particularly effective for exploring global challenges such as climate adaptation, cybersecurity, and energy transitions.
- Experiential Simulations: Simulations, such as CFR's model diplomacy, immerse students in decision making environments where they must negotiate, analyze policy options, and consider the global implications of engineering solutions.

3.4 Integration and Iterative Refinement

The final stage involves the integration and iterative refinement of the framework through testing, continuous data collection and analysis. Prototype modules and course topics are tested in selected engineering courses, including renewable energy systems, cybersecurity fundamentals, and infrastructure resilience. Student focused data is collected through course evaluations, surveys, focus groups and students' reflection assignments. Faculty related data is gathered from interviews. Incorporating faculty perspectives through semi-structured interviews and informal consultations is a strategy that enriches this stage. These conversations generate insights into perceived barriers, opportunities for interdisciplinary collaboration, and faculty readiness to integrate policy content. The feedback from continuous data collection and analysis facilitates an iterative refinement that contributes to shaping the proposed framework, thus making it both academically rigorous and practically feasible. Likely insights from the results and outcomes of the iterative process include but are not limited to:

- Student engagement patterns
- Faculty adoption challenges
- Policy terminology barriers
- Gains from simulation-based learning approach

These insights are to inform applicable revisions that can be made to the framework or reveal opportunities for new implementable ideas into the framework.

4. Curriculum Framework and Operationalization

This section presents the proposed curriculum framework and operationalization of the GAIE competency model (GCM). The framework integrates global policy education into engineering curriculum through three inter-related phases. Each phase is a sustainable strategical approach. A phase can be executed independently at different levels or scaffolded with other phases within the curriculum. These phases which are discussed in this section are: (1) Embedding global policy analysis (2) Examining the policy-technology interface, and (3) Cultivating global perspectives through international case studies and cross-border collaborations. With reference to Bloom's taxonomy, the primary student learning outcomes are that students will be able to analyze, explore and cultivate perspectives on global policy after the implementation of the framework.

4.1 Phase 1: Embedding global policy analysis

The first phase focuses on integrating global policy content directly into existing engineering courses. It minimizes curricular disruption while introducing students' to and enhancing students' understanding of how international governance structures influence technical decision making. The phase is carried out by:

- Identifying integration points: this involves particularly identifying courses that are readily well-suited for policy integration. Through curriculum mapping, courses addressing sustainability, infrastructure, cybersecurity, energy systems, and emerging technologies are applicable. Examples are courses on:
    - Renewable energy systems: in this course, students will be able to analyze how global climate agreements shape national and global renewable energy targets and influence engineering design priorities and strategies discussed in [2] and [19].
    - Cybersecurity fundamentals: for this course, embedding CFR briefings on cyber norms [3] and digital governance [20] will enable students to understand how geopolitical tensions [21] influence cybersecurity infrastructure.
    - Water resources engineering: the course will allow students to examine transboundary water agreements and their implications for infrastructure design and resource allocation as explained in [15].
- Utilizing policy-infused assignments: assignments are designed to connect technical analysis with global policy considerations. These assignments would facilitate students' ability to evaluate tradeoffs between technical performance, policy constraints, and ethical considerations. The focus of such assignments include but not limited to:
    - Evaluating how international emissions targets influence renewable energy system design.
    - Assessing the impact of global supply chain disruptions on semiconductor manufacturing.
    - Analyzing how international data privacy regulations affect AI-enabled systems.
- Use of CFR backgrounders and issue trackers: CFR backgrounders and issue trackers provide accessible, research-based overviews of global challenges that can be integrated into lectures, discussions, and assignments. These resources help students contextualize technical content within global policy frameworks and develop foundational policy literacy.

4.2 Phase 2: Exploring the policy-technology interface

During this phase students are introduced to the dynamic relationship between global policy and emerging technologies. Here, the emphasis is on interdisciplinary learning. Students are educated on the interplay between policy and technology so they can gain insight on how policy decisions shape innovation pathways, funding landscapes, and ethical considerations. This phase is implemented through:

- Thematic Modules: the framework includes thematic modules that explore the policy-technology interface in areas such as:
    - Energy transitions: students examine examples of how international climate agreements influence national energy strategies and renewable technology deployment presented in [4] and [19].
    - Cybersecurity and digital governance: students explore how global cyber norms [20], data privacy regulations [28], and geopolitical tensions shape cybersecurity infrastructure [21].

    - AI and Algorithmic governance: students analyze global debates on AI ethics [5], data sovereignty, and algorithmic transparency using CFR backgrounders and panel interviews [22] and international policy reports [24].
    - Infrastructure Resilience: students examine how global risk influences the design of resilient infrastructure systems using examples of studies in [11], [30], [32].
- Case-Study-Based learning: case studies allow students to analyze real-world scenarios where engineering and policy intersect. It enables students to evaluate policy-driven constraints and develop interdisciplinary reasoning skills. Examples include:
    - The global semiconductor shortage and its impact on manufacturing [31].
    - International negotiations on carbon border adjustment mechanisms.
    - Cross-border cybersecurity incidents and their implications for infrastructure resilience [32].
- Integration of CFR model diplomacy simulations: these simulations immerse students in policy decision making environments where they must negotiate, analyze trade-offs, and consider the global implications of engineering solutions [4]. Students develop communication, collaboration, and system-thinking skills while reinforcing the connection between engineering and global policy. They also align with ABET's emphasis on teamwork, ethical responsibility, and the ability to evaluate global and societal impacts of engineering decisions [12]. Integrating simulations provide students with experiential learning opportunities that mirror real-world policy negotiations and international engineering challenges.

4.3 Phase 3: Cultivating global perspectives

The final phase emphasizes the development of global perspectives through exposure to international case studies, cross-border engineering collaborations, and discussions that connect local engineering solutions to global challenges as explained in [2], [8], [29] and [28]. This phase supports the development of globally competent engineers who can navigate diverse cultural, political, and regulatory environments. This phase is realized using:

- International case studies: these case studies allow students to analyze engineering projects implemented in diverse cultural, political, and economic contexts. Examples include renewable energy deployment in Sub-Saharan Africa [9], water infrastructure development in South Asia [8], smart-city initiatives in East Asia [27], and climate adaptation strategies in coastal regions of Europe [15]. These case studies help students understand how engineering decisions are shaped by local conditions and global policy frameworks. They reinforce the importance of designing solutions that are culturally appropriate, environmentally sustainable, and aligned with international development goals in [2], [30].
- Cross-Border collaboration opportunities: cross-border collaborations encourage opportunities for virtual or in-person collaboration with international partners. The collaborations may include joint design projects with students in international universities, participation in international engineering competitions, and engagement with international and global professional and engineering organizations. Such experiences help students develop cross-cultural communication skills and understand the global nature of engineering practice. They also prepare students for careers in multinational companies

and international development organizations, where collaboration across borders is essential [24], [29].

- Linking local solutions to global challenges: classroom discussions and reflection assignments allow students to connect local engineering solutions to global challenges. For example, students may analyze, discuss and provide their stance on the:
    - Contribution of local renewable energy projects to global climate goals.
    - Influence of local and national cybersecurity decisions on global digital security.
    - Alignment of local infrastructure investments with global sustainability frameworks.

These discussions reinforce the fact that engineering is inherently a global profession with far-reaching implications. They also support ABET's emphasis on understanding the broader impacts of engineering solutions [12].

4. 4 GAIE Competency Model (GCM) operationalization

Table 1 presents the GAIE competency model (GCM). The model includes six measurable expected proficiency termed GAIE competency (GC), the observable outcomes, curriculum framework phase that each GC aligns with and assessment examples that can be used to measure proficiency. The operationalization of the GCM is further expanded in table 2, which outlines how the GCM maps into ABET SLO 2-7. In table 2, primary (P), supporting (S) and indirect (I) are alignment indicators. The justification for the primary, supporting and indirect contributions of each GC to the achievement of ABET SLO 2-7 is briefly explained as follows:

- SLO2 (Design with societal factors): Systems framing (GC2), Scenario reasoning (GC4), and Ethical and societal judgment (GC5) are primary and central because they force designs to satisfy real policy, safety, and societal constraints. As supporting contributors, Policy literacy (G1) and Evidence evaluation (GC3) ensure that engineering designs are compliant and justified while GC6 packages the solution for communication with decision makers.
- SLO3 (Communication): Communication with decision makers (GC6) provides primary contribution while the other five GCs facilitate support because they supply the content, visuals, justifications, and ethical framing needed to communicate effectively to technical and non-technical audiences.
- SLO4 (Ethics and impact): Ethical and societal judgment (GC5) is primary; the remaining competencies are supporting contributors that provide the information landscape, stakeholder mapping, credible evidence, scenario consequences, and clear explanation needed for informed ethical judgment.
- SLO5 (Teamwork): While the GCM is not a "teamwork" rubric per se, each competency maps naturally into collaborative deliverables (policy memo, constraint map, annotated sources, scenario brief, ethics memo, one-page brief), to support inclusive roles, planning, and objective driven teamwork.
- SLO6 (Experimentation and inference): Evidence evaluation (GC3) is primary because it directly contributes to experimental thinking (data vetting, analysis, conclusions). Systems framing (GC2) and Scenario reasoning (GC4) support competency in defining variables and running "what-if" experiments and simulations. GC1 provides supporting and indirect contributions while GC5 and GC6 are indirect contributors.

Table 1. GAIE Competency Model (GCM)

GAIE Competency (GC)	Observable Outcome	Phase Alignment	Example Assessment
GC 1: Policy literacy	Identifies relevant global policy documents and actors	Phase 1	Policy landscape memo
GC 2: Systems framing	Maps technical problems to geopolitical, economic, and regulatory constraints	Phase 2	Constraint mapping diagram
GC 3: Evidence evaluation	Critically evaluates CFR and global policy sources' credibility and relevance	Phase 1 and 2	Annotated source analysis
GC 4: Scenario reasoning	Apply policy scenarios to engineering design decisions	Phase 3	Scenario based design
GC 5: Ethical and societal judgment	Articulates ethical tradeoffs in policy constrained engineering solutions	Phase 3	Short ethics brief
GC 6: Communication with decision makers	Produces concise, policy aware technical recommendations	Phase 3	One page policy informed design brief

Table 2. Mapping GCM with ABET SLO 2-7

GC / **ABET SLO**	**GC1**	**GC2**	**GC3**	**GC4**	**GC5**	**GC6**
SLO2	**(S)** Identifies policy, actors and constraints the design must satisfy	**(P)** Maps technical needs to geopolitical/economic/regulatory limits	**(S)** Grounds design choices in credible sources/data	**(P)** Tests designs against realistic policy scenarios	**(P)** Surfaces trade-offs among safety, equity, environment	**(S)** Delivers design recommendations in decision-ready form
SLO3	**(S)** Writes policy memos for non-technical readers	**(S)** Uses diagrams to explain constraints	**(S)** Presents vetted evidence clearly	**(S)** Justifies choices with scenario narratives	**(S)** Articulates value/impact transparently	**(P)** Produces concise, audience-specific briefs
SLO4	**(S)** Locates norms, standards, public interest mandates	**(S)** Reveals stakeholder impacts and risks	**(S)** Guards against misinformation; supports informed judgment	**(S)** Anticipates consequences of alternatives	**(P)** Performs explicit ethical trade-off analysis	**(S)** Communicates ethical rationale and implications
SLO5	**(S)** Shared policy landscape tasks enable role clarity	**(S)** Collective constraint-mapping supports planning	**(S)** Distributed source-review builds inclusive collaboration	**(S)** Team scenario labs support goal setting & execution	**(S)** Group ethics briefs promote inclusive norms	**(S)** Cadenced briefs and sustainable updates via team coordination
SLO6	**(I) (S)** Curates regulatory datasets to frame tests	**(S)** Defines variables/constraints to probe	**(P)** Critically analyzes data/sources; draws evidence-based conclusions	**(S)** Uses "what-if" policy experiments and simulations	**(I)** Checks compliance and impact criteria	**(I)** Reports findings succinctly
SLO7	**(P)** Continual scanning of evolving policy/standards	**(S)** Integrates new cross-domain knowledge into models	**(P)** Learns new evaluation methods and applies them	**(S)** Adapts designs to new scenarios and assumptions	**(S)** Updates value frameworks as contexts change	**(S)** Refines message forms for varied stakeholders

- SLO7 (Lifelong learning): Policy literacy (GC1) and Evidence evaluation (GC3) explicitly cultivate continuous scanning and method acquisition and thus are primary contributors. Systems framing (GC2) and Scenario reasoning (GC4) demand ongoing integration of new knowledge while GC5 and GC6 evolve as contexts and audiences change.

The mapping presented shows that GCM operationalizes ABET outcomes beyond purely technical proficiency by embedding policy, ethics, systems thinking, and audience ready communication into engineering design practice.

5. Framework integration action plan options

Successful adoption and operationalization of the proposed curriculum framework require intentional planning at the course, program, and institutional levels. Implementation must be flexible enough to accommodate institutional differences while maintaining fidelity of the framework's objectives and sustainability. This section discusses the action plan approaches that facilitate and support the integration and implementation of the curriculum framework as follows.

- Course-Level implementation: course-level implementation [1], [13] focuses on adopting global policy content in existing engineering courses. This option allows faculty to integrate the framework incrementally and adapt the phases to their teaching styles and disciplinary contexts through:
  - Syllabus integration: faculty can incorporate global policy modules into weekly course schedules by adding CFR backgrounders as required or recommended readings, introducing policy-focused discussion prompts during lecture or lab sessions and embedding policy considerations into design projects or problem sets. For example, in a renewable energy systems course, a week on solar energy technologies may include a CFR reading on global climate negotiations, followed by a discussion on how international agreements influence national energy policies.
  - Assessment strategies: these strategies may include policy-infused problem sets, reflective essays, simulation-based performance evaluations, and interdisciplinary design reports. These assessments serve as a tool to measure students' ability to integrate technical and policy considerations, thus aligning with ABET's emphasis on communication, ethical reasoning, and global awareness [12].
- Program-Level implementation: program-level implementation [25] expands the framework beyond individual courses to create a cohesive, interdisciplinary learning environment across the engineering curriculum. The options at this level include:
  - Certificate or minor in global engineering policy: Institutions may develop a certificate or minor program that includes core courses on global policy and international affairs, elective engineering courses with integrated policy modules, and a capstone project addressing a global socio-technical challenge. Such programs provide structured pathways for students interested in careers at the intersection of engineering and policy. The proposed curriculum framework may be scaffolded in this option.
  - Integration with capstone design: capstone design courses offer natural opportunities for integrating global policy perspectives. Students can analyze how international regulations, global supply chains, and geopolitical risks influence their design

decisions. This integration option reinforces the importance of designing solutions that are globally informed and resilient.

- Institutional Partnerships: Institutional partnerships enhance students' understanding through real-life, hands-on experiential learning. It provides additional resources, professional expertise, interaction with experts and opportunities for student engagement and internships. Examples include:
  - Collaboration with CFR: partnerships with CFR can include guest lectures from CFR experts, access to exclusive educational materials, and participation in CFR academic programs and events. These collaborations strengthen the connection between engineering education and global policy discourse.
  - Collaboration with international organizations: Partnerships with international organizations such as the United Nations [9], the International Telecommunication Union [24], and the World Bank [30] can provide students with access to global datasets, policy frameworks, and case studies. These partnerships also support experiential learning opportunities such as internships, research projects, study-abroad, internship-abroad and international field experiences.

A pilot test example of using mixed-methodology design to evaluate the proposed curriculum framework integration is to have two engineering courses as participants with intervention dose of one 2-week module and one 3-week module respectively. The measurement instruments include pre and post GAIE competency survey, rubric scored artifacts, short reflective prompts, instructor field notes and faculty interviews. Quantitative analysis will involve paired t-tests on competency gains; inter-rater reliability (Cohen's κ) for rubric scoring. Thematic coding, audit trail, and member-checking for trustworthiness are leveraged for qualitative analysis.

6. Expected Outcomes and benefits

The proposed curriculum framework is designed to facilitate engineering students' global awareness, socio-technical reasoning, and interdisciplinary problem-solving abilities. By integrating global policy perspectives into engineering coursework, the framework prepares engineers who can navigate the increasingly complex intersections of technology, governance, and international affairs. In the section, the expected outcome with brief discussion is provided. Following the research methodology, the student focused outcomes and benefits that are expected from the implementation of the curriculum framework include:

- Enhanced policy literacy: students develop foundational literacy in global policy concepts, including international governance structures, geopolitical dynamics, and global regulatory frameworks. This literacy enables students to analyze how policy decisions influence engineering practice and technological innovations.
- Strengthened socio-technical reasoning: by analyzing how global policy influences engineering design, students improve their ability to evaluate tradeoffs between technical performance, policy constraints, and ethical considerations. This outcome aligns with ABET's emphasis on ethical responsibility and an understanding of the broader impacts of engineering solutions.
- Improved communication and collaboration skills: participation in CFR simulations and policy-infused assignments will enhance students' communication, negotiation, and

teamwork skills. These competencies are essential for global engineering practice [3], [18]. They are the skills also emphasized in ABET's student outcomes [12].

- Increased engagement with global challenges: exposure to international case studies and cross-border collaborations will enlighten students. Thus, they will be inspired to contribute to solving global sustainability, cybersecurity, and energy transition challenges. This engagement prepares students for careers in globalized industries and international development organizations.

The integration of global policy perspectives into engineering education represents a significant shift from traditional, technically focused curriculum. This shift aligns with broader trends in engineering education research, which emphasize interdisciplinary learning, ethical reasoning, and global competency. The contributions of the proposed curriculum framework are:

- Addresses curricular gaps: the framework addresses the policy-technology interplay gaps in engineering education by providing structured opportunities for students to engage with global policy educational content. While many programs acknowledge the importance of global awareness, few offer systematic approaches for integrating global policy content and analysis into engineering and technical courses.
- Enhancement of workforce readiness: engineering employers increasingly seek graduates who can navigate global regulatory environments, assess geopolitical risks, and communicate effectively across cultural and disciplinary boundaries. By integrating global policy perspectives into engineering curriculum, the framework enhances students' readiness for the global workforce of the future as mentioned in [24], [29] and [33].
- Support for accreditation and continuous improvement: the framework supports the achievement of ABET accreditation by aligning with SLOs related to ethics, communication, teamwork, and understanding the global and societal impacts of engineering solutions. Integrating global policy content into engineering curricula also supports continuous improvement efforts by encouraging faculty to adopt innovative pedagogical approaches.

7. Conclusion

Engineering is inherently a global profession, shaped by international policy decisions, geopolitical dynamics, and global sustainability challenges. As emerging technologies continue to transform societies, engineers must be prepared to navigate the complex intersections of technology and global policy. This work in progress paper offers a timely and comprehensive curriculum framework that integrates global policy perspectives into engineering education using resources from CFR and global organizations. The novelty of the work is an operationalization of the framework in a three phased structure through the GCM (Table 1) and a direct mapping to ABET SLO 2–7 (Table 2). By leveraging course-level integration, program-level initiatives, and institutional partnerships, the framework provides a scalable and adaptable model for preparing global affairs informed engineers (GAIE) with expertise and competency in global awareness and engineering. The framework's emphasis on policy literacy, socio-technical reasoning, interdisciplinary learning, and global engagement aligns with contemporary engineering education research and workforce needs. The curriculum provides actionable learning outcomes and implementable assessment artifacts such as a policy memo, constraint map, annotated source analysis, scenario based design justification, ethics, policy/design brief, which makes it usable for instructors. Adopting this framework would enable engineering programs to better prepare students to lead in a world where technology and international affairs are deeply interconnected.

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